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MODELLING OF BEARING WEAR UNDER CONDITIONS OF SHAFT AND BUSHING AXIS MISALIGNMENT

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Modeling of wear processes is an important step in the design of machinery. Such virtual studies allow us to predict the service life of components and the machine as a whole. Parts have high requirements for manufacturing and assembly accuracy, but within the tolerance fields, errors in relative positioning are still allowed, which in turn can significantly affect the service life of the mechanism.

During machine operation, rotating and moving parts, such as shafts and bushings, are subject to the greatest wear and tear, so analyzing their service life is an important task. These parts are subject to high requirements for manufacturing and assembly accuracy, but within the tolerances of the fields, errors in relative positioning are still allowed, which in turn can significantly affect the service life of the mechanism. Therefore, the task of modeling the wear process of a shaft and a sleeve under conditions of mutual misalignment of the axes (Fig. 1) is relevant, since such sliding pairs exist in almost all machines.

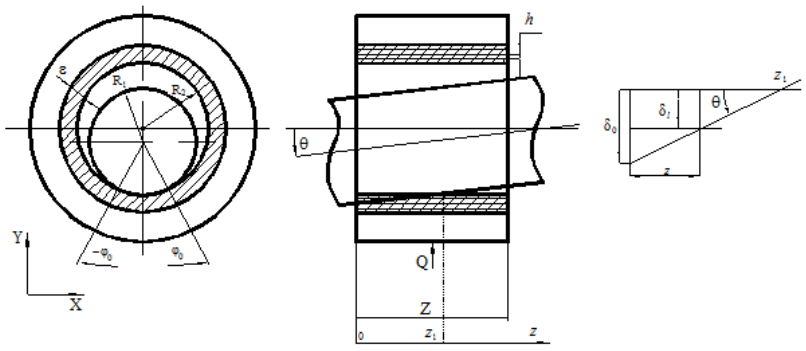


Fig. 1. Schematic diagram

The visualization of repeated cyclic loads in a graphical format is characterized by the reproducibility of large arrays of numerical data reduced to a unified form. If we consider the information presented in the form of multidimensional matrices with

statistical data, the level of perception of such information is much lower than in a visual form.

Creating multidimensional data matrices is a mandatory step in process modeling for further analysis. Static matrices describe processes based on fundamental laws, while dynamic matrices include all iterative processes. When studying physical processes (especially iterative ones), there are cases when the relevant data cannot be fully displayed by a three-dimensional graph separated by a color spectrum, since it is impossible to demonstrate the dynamic process of changing parameters over time using a static image. In such cases, it is advisable to use animated types of data representation, which allow you to visually display the change in the state of the processes depicted on a three-dimensional graph over time.

To solve this problem, a module for calculating the wear of a friction unit was developed. The first step of the module is to initialize and create a graphical model based on the data obtained. The created geometric model is divided into finite elements, after which a contact pair is created and the restrictions on the freedom and magnitude of the friction unit loads are set. After the appropriate calculation, the built geometric model is destroyed and the process is repeated again for the number of iterations specified by the user.

The basic interface of the developed software product is shown in Fig. 2. In order to increase the level of perception of the information depicted in the graph, the module implements the appropriate tools. The toolkit allows you to shift and rotate the graph around the abscissa and ordinate axes, scaling and step-by-step plotting. This step-by-step construction allows you to highlight the moments of transition from normal operating conditions of the unit to critical wear conditions.

As part of the study of the effectiveness of the system for modeling and visualizing wear processes, it was tested on data characterizing various variants of the dynamics of wear and pressure processes as part of solving the problem of wear of radial plain bearings with misalignment of the shaft and sleeve axes.

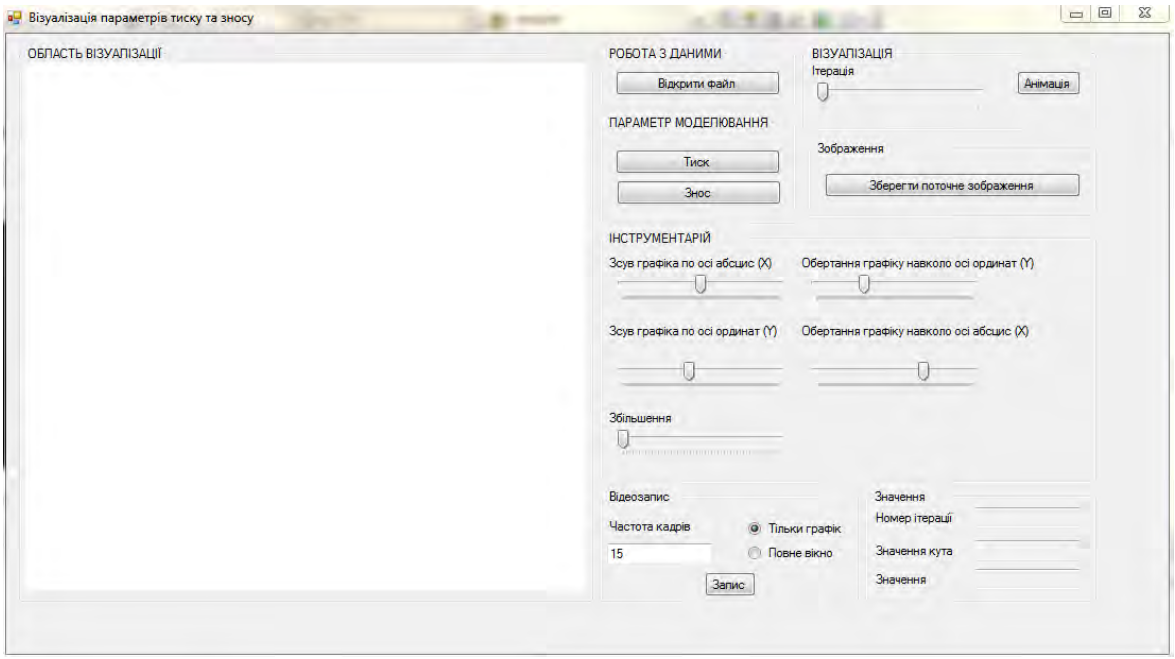
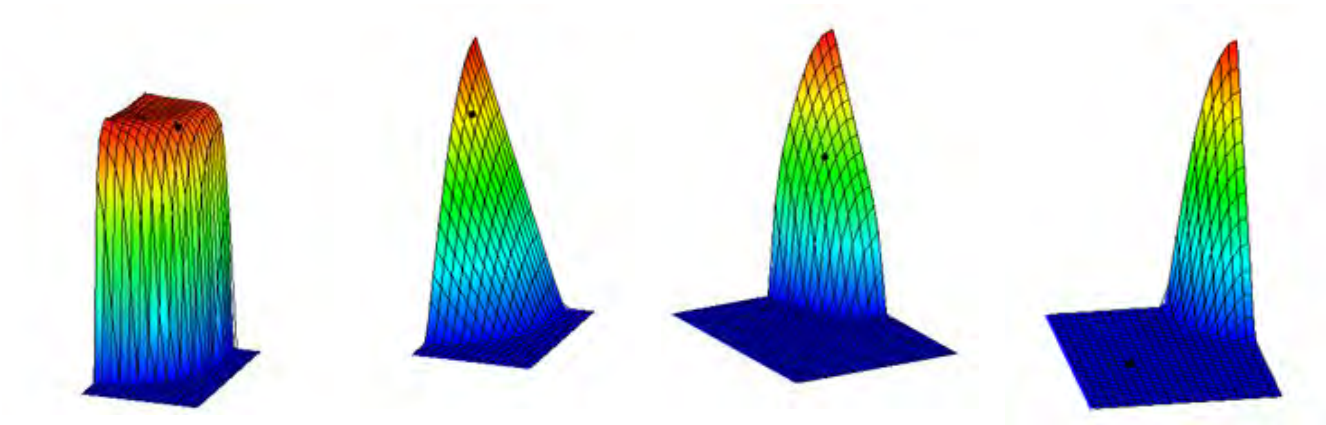


Fig. 2. Basic interface of the program

For example, Fig. 3 shows graphs of pressure versus time under the condition of a rapid initial pressure value (Fig. 3, a), a smoothed pressure versus time when studying the wear process of a shaft and a sleeve under the condition of mutual misalignment of their axes (Fig. 3, b), as well as cases of a sudden increase in pressure in a critical situation in the form of peak dynamics of change in friction pair elements (Fig. 3, c), and a linear dependence of the wear process of friction pair elements depending on the operating time of the mechanism (Fig. 3, d).



a b c d

Fig. 3. Examples of building shaft and bushing wear models

For better perception of information and further analysis of critical areas of the node's operating conditions, the module implements scaling along the abscissa and ordinate axes, as well as rotation of the graph relative to its axis. In addition, the program implements the extraction of a specific value from a multidimensional input data matrix. To do this, the user needs to click on the corresponding area of the graph and the corresponding data in numerical format will be displayed in the Iteration number, Angle value and Wear value fields.

If it is necessary to present dynamic information in the absence of the module, it implements the ability to record video files, which has several functions. The program also provides the ability to save the current image in the visualization area.

Conclusion: The developed system allows visualizing various cases of time changes in pressure and wear parameters, wear processes of friction elements, which allows taking into account the mutual influence of wear and changes in operating conditions during operation. In addition, the use of such a system by an expert in the relevant subject area, in which there is a need to process multidimensional matrices, leads to the prompt identification of critical situations in the operation of the mechanism.

With the help of visual display of multidimensional numerical matrices, it is possible to analyze the overall dynamics of the wear and friction process, obtain specific data at a certain period of time of the mechanism operation, use the obtained multimedia files to demonstrate the modeling process in the future, depending on the needs (scientific, educational, analytical, etc.). The scope of the developed module is defined as its use in any field of knowledge in which there are multidimensional data matrices, especially in those areas in which the data change over time or by another parameter.

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